EXPERT REPORT OF DR. MICHAEL THOMAS

Lafarge Canada Inc., et al v. American Home Assurance Co., et al., 15-cv-8957

Appendix B

List of Materials Considered

Pleadings and Discovery Materials

Transcript of January 11, 2017 deposition of Martin Perreault.

Transcript of January 27, 2017 deposition of Anik Delagrave.

Transcript of February 15, 2017 deposition of Alain Canuel.

Transcript of February 17, 2017 deposition of Marie de Grosbois.

Documents from Underlying Trois-Rivières Litigation

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[redacted]

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EXPERT REPORT OF DR. MICHAEL THOMAS

Lafarge Canada Inc., et al v. American Home Assurance Co., et al., 15-cv-8957

Appendix C

LAF0000631949-53

MARKETING 4135773740 1/ 2

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LAFARGE CANADA INC
[illegible] Cathcart, Montréal, Québec [illegible]
Téléphone: (514) [illegible] Fax: (514) [illegible]

106

From: Pascale Pavlic
Claude Varville

cc: Daniel Odeury

Re: Grande-Grésillons
Project #: Cement samples
Sample Name: 2BO-01 #1

CHEMICAL ANALYSIS

Sample Identification	Lafarge Test	SiO2	Al2O3	Fe2O3	CaO	MgO	LOI	Li2O	K2O	Na2O	TiO2	P2O5	Mn2O3	SrO	Total	% Equivalent Pyrite
2BO-01 #1	[illegible]	12.73	14.17	1.34	1.38	6.31	[illegible]	1.34	4.78	4.8	0.23	0.24	0.06	0.06	101.34	0.12

Standard used for the quality control : [illegible]

The chemical analysis was performed by XRF for major elements and by Leco SC-432 for sulfur.

All results are expressed in % w/w. All analyses are performed in duplicate.

We hereby certify that the above test results were determined using state-of-the-art equipment including quality assurance, quality control and strictly adhered to procedures set forth in the CSA test manuals.

This is the final report, no paper copy will be distributed.

Comments : The sum of all elements [illegible] is higher than our limit of tolerance which is 100 ± 1 %. This can be explained by the fact that the sulfur is lost with the LOI and then added to the total [illegible]. This fact is [illegible], which is why the LOI is [illegible] than the total [illegible] value.

Test done by : [illegible]

107

Lab request # 52-2002-0036
Pascale Poulin to: Marie deGrosbois, Martin Perreault 02/18/2002 11:44 AM

The status of the request 52-2002-0036 has just changed to "Done"
Any report attached to the request will now be visible.
You can click the link to go directly to the Request:

[redacted] Back To Menu

[redacted]

52-2002-0036

Problem with Status

02/15/2002

SBO-01-P1

02/06/2002

1 sac de granulat 5-14mm

0

granulat granitique

[redacted]

Marie deGrosbois/CTS/Ca/Cement/Lafarge, Martin Perreault/East_Region/Ca/Cement/Lafarge

☐ CTS

Denis Leblanc/CTS/Ca/Cement/Lafarge

Pascale Poulin

0500-U07801

[redacted]

☒ Chem ☐ Concrete ☐ Mortar

Available Tests | Selected Tests 2

☒ Pyrite content

urgent - doit être fait en moins de 2 semaines - SVP confirmation

11.5

Claude Verville and Pascale Poulin

Request History

[redacted]

02/05/2002
02/05/2002
02/08/2002

[redacted] 02/11/2002
02/18/2002
02/18/2002

EXPERT REPORT OF DR. MICHAEL THOMAS

Lafarge Canada Inc., et al v. American Home Assurance Co., et al., 15-cv-8957

Appendix D

LAF0000023031-56

Terratech

Division de
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Télécopieur: (514) 331-7632

ISO 9001

PETROGRAPHIC EXAMINATION

ASTM C295 – ASTM C856

Client	: Carrière B et B	File no	: 602071-0045
	:	Sample no	: 001
Project	: Testing on materials	Client Ref	: -
	:	Date	: December 2, 2003

1.0 GENERAL INFORMATION

Type of samples	: Crushed stones 5-10, 10-14 and 14-20 mm
	Carrière B et B, Saint-Boniface, Qc
Instruments used	: Stereomicroscope and polarizing optical microscope

2.0 RESULTS

1.0 GENERAL

We have a crushed stone with a caliber of 5-20 mm. It is a meta-igneous stone with two distinct facies. The main facies is represented by a medium-grained mafic rock. The second facies is made of a medium-grained more felsic gneiss. A petrographic number (NQ 2560-900) was first conducted to determine in megascopy the types of facies present and evaluate their mechanical properties. Afterwards, some ten fragments were mounted on thin section in order to determine more precisely the mineralogy in microscopy.

2.0 MEGASCOPIC DESCRIPTION

The sample is composed of a gneiss with two distinct facies. The main facies (representing ~ 90% of the total) is medium-grained with a greenish-black colour. We did not distinguish any texture and/or particular structure throughout the sample. The rock does not present any alteration with the exception of a slight surface oxidation on rare particles. The mineralogy seems dominated by some hornblende. We also noted the presence of about 3 to 5% of iron sulphide (pyrite and pyrrothite). There is little to no oxidation associated to them. A second facies (representing about 10%) is composed of medium-grained and slighty banded quartzo-feldspathic gneiss. The rock did not present any distinct alteration. The mineralogy is mainly made of pink feldspar and quartz. We can see also the presence of a few biotite (grains) (5%). There are no visible massive sulphide thoughout the sample.

For the petrographic number, the main facies was identified as hornblende gneiss. This facies has a petrographic factor of 1.0 or 1.2 depending on grain size. The second facies was identified as a quartzo-feldspathic gneiss. A petrographic factor of 1.2 was given. The global petrographic number of the sample is 112, which reflects the good physical properties of this sample.

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ISO 9001

PETROGRAPHIC EXAMINATION

ASTM C295 – ASTM C856

Client	: Carrière B et B	File no	: 602071-0045
	:	Sample no	: 001
Project	: Testing on materials	Client Ref.	: -
	:	Date	: December 2, 2003

2.0 RESULTS (continued)

3.0 MICROSCOPIC DESCRIPTION

Hornblende and chlorite dominate the mineralogy (50%). We then find feldspars (25%), biotite (10%), quartz (10%) and opaque minerals; essentially iron sulfides (< 5%). The crystals are not well defined and we notice an alteration of the hornblende into chlorite. The structure is granular and for the total of the sample, only the quartzo-feldspathic facies presents a banding for the quartz and the feldspars. The quartz presents moderate undulatory extinctions. The iron sulfides (pyrite or pyrrhotite) appear to be a massive but very fine grain. No framboidal crystal was identified in the samples mounted on thin sections. Furthermore, these sulfides for all of the fragments, do not appear to be grouped particularly, but instead they seem to be mostly disseminated.

4.0 CONCLUSION

Following the megascopic and microscopic analysis of the crushed stone rock sample originating from Carrière B et B in Saint-Boniface, Qc, our conclusions are the following:

- The sample presents good mechanical and physical properties as reflected by the petrographic number of 112.
- In regards to the alkali-aggregate reactivity, the percentage of quartz seems relatively low (15 to 20%) and the quartz does not show a very intense undulatory extinction. We are of the opinion that this stone is not reactive to the alkali from the Portland cement. This conclusion will have to be confirmed by an expansion test on concrete prisms performed according to the CSA A23.2-14A standard.
- In regards to the presence of iron sulfides (pyrite and pyrrhotite), the percentage appears to be in the range of 3% and these crystals are disseminated in the mass. They appear massive and not in the framboidal form. Considering the low absorption percentage of this rock, we are of the opinion that the sulfides found do not present a potential for the sulfation of concrete when used in a good-quality normal volumic mass concrete, and not presenting excessive fissuration.

Therefore, considering the results obtained, we are of the opinion that the crushed stone originating from Carrière B et B in Saint-Boniface, represents a good concrete aggregate that can be used without the risk of developing a harmful reaction.

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ISO 9001

PETROGRAPHIC EXAMINATION

ASTM C295 – ASTM C856

Client	: Carrière B et B	File no	: 602071-0045
	:	Sample no	: 001
Project	: Testing on materials	Client Ref	: -
	:	Date	: December 2, 2003

2.0 RESULTS (continued)

Notes:

- *The methodologies and analysis techniques used are those recommended by the ASTM C295 norm. Considering the present scientific knowledge, they represent, in our opinion, an adequate global evaluation method for concrete aggregates.*
- *Accordingly, the conclusions are a professional opinion that takes into account the results obtained with the methodology and techniques used and the experience acquired through case history.*
- *The results and conclusions found in this report apply to the sample analysed and are not representing a global evaluation of the quarry.*

Testing done by: Christian Boucher, géol. stag. Approved by:

Alain Blanchette, géol., M.Sc.A.
Projet Manager
Materials Engineering

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Division de SNC-LAVALIN Environnement inc.
[illegible], Benjamin-Hudon
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ISO 9001

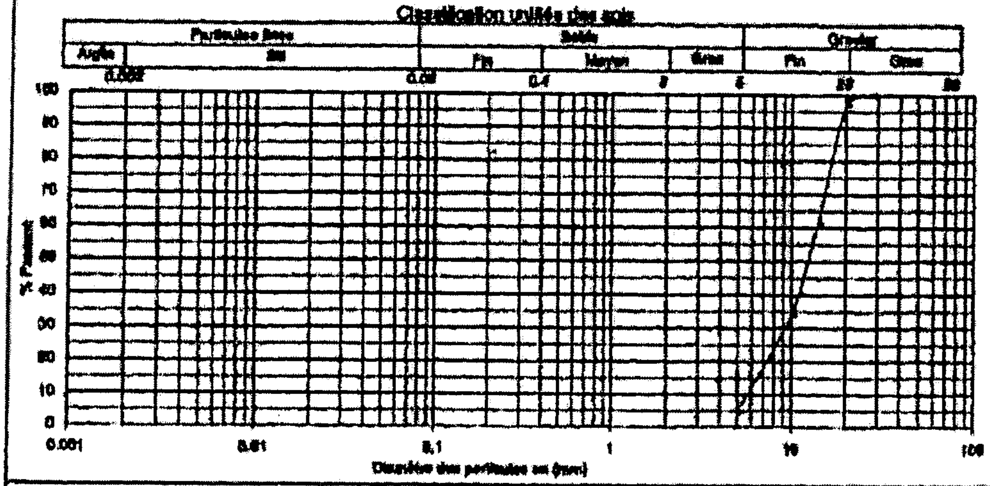
Essais sur sols, granulats et autres matériaux

Client :	Carrière B et B	Matériau :	P.C. 5-10mm, 10-14 mm et 14-20 mm
:		Provenance :	Carrière B et B
Projet :	Essais sur matériaux	:	St-Boniface, Québec
:		Utilisation :	Béton de ciment
No dossier:	602071-0045	Prélevé le :	- Reçu le: 03-10-22
Échantillon No :	001	Échantillonné par:	Client Ref Client:

Analyse granulométrique (LC 21-040)			Autres essais		Mesuré	Exigé
Tamis mm	Tamisat (% Passant)		Nombre pétrographique	NQ 2560-900	112	
	Mesuré	Exigences	Examen pétrographique	ASTM C295	*	
112						
80						
56						
40						
28	100					
20	97					
14	61					
10	34					
5	5					
2.500						
1.250						
0.630						
0.315						
0.160						
0.080						

Essai Proctor modifié (NQ 2501-255)		
Méthode	Masse volumique sèche maximale	Teneur en eau optimale

Classification unifiée des sols


Particules fines
Argile
Silt
Sable
Fin
Moyen
Gros
Gravier
Fin
Gros
0.002
0.08
0.4
2
5
20
80
% Passant
100
90
80
70
60
50
40
30
20
10
0
0.001
0.01
0.1
1
10
100
Diamètre des particules en (mm)

Remarques:

* Voir feuilles ci-jointes

Les essais ont été réalisés sur un mélange, de part égale, des trois (3) échantillons

Essais réalisés par: R.C.
Date: 03-10-28

Vérifié par: G. Lamarche, technicien senior, Chef de laboratoire

Approuvé par: A. Blanchette, géol. Chargé de projet

GÉOLOGUE / GEO... QUÉBEC

FM619-011-REV.00(90.08).xls

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ISO 9001

NOMBRE PÉTROGRAPHIQUE NQ 2560-900

Client	: Carrière B et B	Date	: 1er décembre 2003
		Dossier	: 602071-0045
Projet	: Essais sur matériaux	Labo n°	: 001
		Réf. client	: -

Échantillon	: p.c. 5-10, 10-14 et 14-20 mm
Source	: Carrière B et B, Saint-Boniface, Qc
Prélevé par	: Client le : -
Localisation	: -

Masses utilisées

Passant	20	mm	Retenue	14	mm	Masse	500	g
Passant	14	mm	Retenue	10	mm	Masse	250	g
Passant	10	mm	Retenue	5	mm	Masse	100	g
Passant		mm	Retenue		mm	Masse		g

Tableau synoptique

Faciès pétrographiques	Facteur	% retenu 14 mm	N.P.	% retenu 10 mm	N.P.	% retenu 5 mm	N.P.	% retenu mm	N.P.
Gneiss à amphibole à grain fin	1.0	49	49	42	42	27	27		
Gneiss à amphibole à grain moyen	1.2	45	54	43	51.6	67	80.4		
Gneiss quartzo-feldspathique à grain moyen	1.2	6	7.2	15	18.0	6	7.2		
Nombres pétrographiques par fraction			110.2		111.6		114.6		

Nombre pétrographique : 112

REMARQUES

[Stamp: Géologue / Geologist — Alain Blanchette — Québec] [signature]

Christian Boucher, géol. stag.
Réalisé par

Vérifié par: Alain Blanchette géol. M.Sc.A.

Feuille 1 de 1

IDS-15-005 REV.01 (01-06)

November 18, 2004

Mr. Richard Beauchesne
Carrière B et B
7200, 36ème Avenue
C.P. 184
Shawinigan, Quebec
G9N 6T9

SUBJECT: **Tests on granular materials**
- Petrographic examination according to ASTM C 295
- Crushed stones between 5-14 mm and 10-20 mm

Carrière B et B
St-Boniface, Quebec
Our reference: 602071-0045, labo # 8

Sir,

We are pleased to submit to you the results on the granular material testing that was done on the samples mentioned above.

The results we obtained indicate that:

- The materials are essentially composed of hornblende gneiss that show good mechanical properties as demonstrated by the petrographic number of 116.

- The mineralogical composition is dominated by the presence of alkali feldspar and hornblende. We also observed between 5 to 7% of iron sulfide (pyrite and pyrrhotite). This percentage appears higher than the one found in samples taken from the same quarry and analysed over the last few years.

- The standards in place recognize that a percentage of iron sulfide that is too high can result in the concrete's degradation through a sulfation phenomenon. However, the standards do not specify the acceptable percentage. This is a complex matter considering that iron sulfides can present themselves under different crystal forms (cubic, framboidal, etc.). The crystal form has a direct influence on the oxidation potential of iron sulfides.

- In our opinion, the recognized percentage of iron sulfide found in the samples brings in certain limitations to their use, particularly in regards to architectural concretes and/or exposed aggregates.

- Although the percentage of sulfides present and their crystal form cannot, in our opinion, create a harmful degradation through sulfation, the iron oxides that could develop on the elements' surface however, could generate a negative effect on these elements' aesthetic appearance.

- We also think that these aggregates can be used in standard concretes of normal volumic mass poured on site.

- We recommend a follow-up of the production at the quarry to insure that the aggregates to be produced do not present a higher percentage of sulphides than those found in analysed samples. Tests as density determination and chemical analyses could be performed in order to validate the petrographhv and sulphides content variations.

The detailed results are found attached.

We hope this report meets with your entire satisfaction, and we invite you to contact us should you require any further information.

Sincerely,

TERRATECH,
A Division of SNC•Lavalin Environnement Inc.

Alain Blanchette, géologue M.Sc.A.
Project Manager
Materials Engineering

AB/nb

p.j. Appendix A : Petrographic Examination (3 pages)
Appendix B : Petrographic Number (4 pages)

ANNEXE A

Petrographic Examination

Terratech

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ISO 9001

PETROGRAPHIC EXAMINATION

ASTM C295 – ASTM C856

Client	Carrière B et B	File no	: 602071-0045
	St-Boniface (Québec)	Sampler no	: 008
Project	Testing on materials	Client Ref	: N/D
	:	Date	: November 10, 2004

1.0 GENERAL INFORMATION

Sample types	Crushed stones, 5-14 mm and 10-20 mm
	Carrière B et B, Production 2004, St-Boniface (Québec)
Instruments used	Stereomicroscope and polarizing optical microscope
Other information	: The petrographic testing was conducted on a combination of two calibres of crushed stones.

2.0 RESULTS

1.0 GENERAL

The petrographic examination was conducted essentially with the perspective of using these stones as concrete aggregate. The two calibers of stones were initially submitted to a petrographic number analysis to identify the types of facies present in magascopy. Afterwards, representative samples were mounted on polished thin sections in order to be analysed in polarized light microscopy.

2.0 RESULTS

2.1 Petrographic Number (NQ 2560-900)

The production of petrographic numbers enabled us to determine the presence of meta-igneous rock types; three (3) facies were identified, one fine-grained amphibole gneiss (≈20%), one medium-grained amphibole gneiss (≈50%) and finally a medium-grained quartzo-feldspathic gneiss (≈30%). All these facies present good physical properties as shown by the petrographic number of 116 obtained for the two (2) samples.

Throughout the samples, no particular texture was recognized and no significant alteration was identified.

2.2 Mineralogy

- In thin sections, the identified materials in descending order are alkaline-feldspars, hornblende-chlorite, quartz, mica (biotite), and iron sulfides.
- The feldspars and hornblende percentages vary from one fragment to the next, but both (2) minerals represent more than 75% of the entire sample.
- Quartz shows only weak undulatory extinction in thin sections.
- Biotite is essentially found in a small concentration, sometimes slightly oxidized.

Terratech

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ISO 9001

PETROGRAPHIC EXAMINATION
ASTM C295 – ASTM C856

Client	Carrière B et B St-Boniface (Québec)	File no	: 602071-0045
		Sample no	: 006
Project	: Testing on materials	Client Ref.	: N/D
		Date	: November 10, 2004

2.0 RESULTS (continued)

- The documents also do not talk about the crystalline form of these iron sulfides, which yet has an important bearing on the "reactivity" level of these minerals.
- Regarding the analysed sample, the 5 to 7% percent found in that sample is in our opinion, a limit that should not be exceeded. Considering the crystalline form of these sulfides that appears essentially to be massive, it is our opinion that they cannot oxidise rapidly in an environment such as a good quality and well proportioned concrete.
- However, a certain proportion of the sulfides is found as being very fine crystals that can oxidise rapidly when exposed to high humidity levels. Consequently, we are of the opinion that the aggregate should not be used in architectural concrete and/or with exposed aggregates. The iron oxides resulting from the oxidation of sulfides would create differences in colour at the concrete's surface.
- As for concrete with a normal volumic mass, cast-in-place and well proportioned, we are of the opinion that these aggregates can be used, but one will have to assure that a production follow-up will insure that the iron sulfides percentage does not rise above that in the analysed sample.
- We are also of the opinion that, considering the possible consequences a more exhaustive study of the quarry be carried out to adequately identify the lateral and vertical variations of the petrographic facies to be exploited and to identify, if needed, the sectors having the higher quality aggregates relative to their mineralogical composition.
- Therefore, for the time being, in the absence of precise standards on the percentage of iron sulfides that concrete aggregates can have before becoming problematic. The identified percentage (5 to 7%) brings in certain limitations on the use of these materials. A follow-up of the production will have to be carried out for not putting on the market aggregates with more iron sulfides than those analysed. The study of the quarry will need to focus on sectors that present the least possible amount of iron sulfides. A percentage of 5% or less (depending on the crystalline form of sulfides) should be focused on during the exploitation.
-

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ISO 9001

PETROGRAPHIC EXAMINATION
ASTM C295 – ASTM C856

Client	Carrière B et B	File no	: 602071-0045
	St-Boniface (Québec)	Sample no	: 008
Project	Testing on materials	Client Ref.	: N/D
		Date	: November 10, 2004

2.0 RESULTS (continued)

- The iron sulfides essentially comprise pyrite and pyrrhotite representing between 5 and 7% of the entire sample. These sulfides are generally massive and without a distinct form. They can sometimes be found as a plating on the fragments' surface, and then presenting more advanced oxidation levels. The sulfides are generally unaltered. We can observe, randomly, on the fragments' surface a few crystals that present a slight superficial oxidation.

3.0 CONCLUSION

Following the analysis made in megascopy and in microscopy of the crushed rock samples (10-20 mm and 5-14 mm) originating from Carrière B et B in Saint-Boniface, our conclusions are the following:

- The sample is made of fine to medium-grained hornblende gneiss.

- The stone presents good mechanical and physical properties as demonstrated by the petrographic number of 116.

- Few alterations are identified except for the slight oxidation of micas and of iron sulfides on the samples' surface.

- The stone shows but a low percentage of quartz (10 to 20%) with weak and low undulatory extinctions. We are therefore of the opinion that this stone does not present a potential for a harmful alkali-silica reaction in the cement. This conclusion will have to be confirmed by an expansion test on concrete prisms, according to the CSA A23.2-14A standard.

- Regarding the presence of iron sulfides, the percentage of 5 to 7% is higher than some samples previously analysed from this quarry.

- The scientific literature and Canadian standards (CSA A23.1) recognize that iron sulfides can react with certain phases of hydrated cement and generate sulfatation with the cement paste, producing fissuration and degradation of the concrete. No normative document specifies the percentages at which the presence of iron sulfides is problematic.

IG610-147-REV.00(02-07)

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Qualité ISO 9001

PETROGRAPHIC EXAMINATION
ASTM C295 – ASTM C856

Note:

- *The methodologies and analysis techniques used are those recommended by the ASTM C295 norm. Considering the present scientific knowledge, they represent, in our opinion, an adequate global evaluation method for concrete aggregates.*
- *Accordingly, the conclusions are a professional opinion that takes into account the results obtained with the methodology and techniques used and the experience acquired through case history.*
- *The results and conclusions found in this report apply to the sample analysed and not on a global evaluation of the quarry.*

Testing done by: Terratech

Approved by: ______________________
Alain Blanchette, géol., M.Sc.A.
Project Manager
Materials Engineering

IGS10-147-REV 00(02-07)

Terratech

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ISO 9001

PETROGRAPHIC EXAMINATION
ASTM C295 – ASTM C856

Client	Carrière B & B St-Boniface (Québec)	File no	602071-0045
		Sample no	013
Project	Quality control	Client Ref.	N/D
		Date	December 12, 2005

1.0 GENERAL INFORMATION

Sample types	Crushed stones, 5-14 mm, 10-20 mm and 14-20 mm Carrière B & B, St-Boniface (Québec)
Instruments used	Stereomicroscope and polarizing optical microscope
Other information	The petrographic testing was conducted on a combination of three (3) calibres crushed stone mounted on polished thin sections

2.0 RESULTS

IG910-147-REV 00(02-07)

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PETROGRAPHIC EXAMINATION

ASTM C295 - ASTM C856

1.0 GENERAL

The petrographic examination was essentially carried with the perspective of using these crushed stones as concrete aggregates. The three (3) calibers of stone were initially used to obtain a petrographic number in order to determine the types of facies present in megascopy. Afterwards, typical samples were mounted on polished thin sections in order to be studied with polarized and reflected light microscopy.

2.0 RESULTS

2.1 Petrographic Number (NQ 2560-900)

The production of petrographic numbers enabled to determine the presence of meta-igneous rocks and three (3) facies were identified, one fine-grained anorthositic gabbro (≈15%), one medium-grained anorthositic gabbro (≈75%) and finally the same anorthositic gabbro, but that presented a superficial oxidation (≈10%). All these facies present good physical properties as indicated by the petrographic numbers of 119, 120 and 121 obtained on the three (3) stone calibers.

Throughout the samples, no particular texture was recognized and no significant alteration was identified.

2.2 Mineralogy

- In thin sections, the identified minerals by decreasing order are plagioclase feldspar, pyroxenes and amphiboles. Then, we find some biotite, quartz, and traces of garnet.
- The sizes and percentages of feldspars, pyroxenes and hornblendes vary from one fragment to the next but the three (3) minerals make up over 75% of the total sample.
- The quartz presents only low undulatory extinction in thin sections.
- The biotite is essentially found in small amounts, sometimes slightly oxidised.

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PETROGRAPHIC EXAMINATION
ASTM C295 – ASTM C856

Client	Carrière B & B	File no	602071-0045
	St-Boniface (Québec)	Sample no	013
Project	Testing on materials	Client Ref	N/D
		Date	December 12, 2005

2.0 RESULTS (continued)

- The iron sulfides are mainly consisted of pyrite and pyrrhotite that represent from 2 to 3% of the total composition. The chemical analysis performed on a composite sample indicates an equivalent percentage of pyrite of 2.26%. These sulfides are generally massive and without a distinct crystal form. We find them occasionally plating the fragments' surface, and then show more advanced levels of oxidation. The sulfides are generally unaltered.

3.0 CONCLUSION

- The three (3) calibers of crushed stones (5-14, 10-20 and 14-20 mm), originating from Carrière B & B in St-Boniface, present good physical properties as indicated by the petrographic numbers of 119, 120 and 121. The physical testing required by the standards (Micro-Deval, Los Angeles, etc.) should validate that these materials meet the physical requirements specified by the current standards in force regarding concrete aggregates.
- On a chemical level, the percentage of quartz is relatively low and presents only low undulatory extinction. Therefore, we think that these facies are not reactive to the alkali in the Portland cement (alkali-aggregates reaction). This conclusion will have to be confirmed by an expansion test on concrete prisms according to the CSA A23.2-14A standard.
- Regarding iron sulfides, pyrite and pyrrhotite, were identified in thin sections and the chemical analysis on a composite sample indicated a percentage of 2.26%. The sulfides are identified as being generally in the massive form.
- The CSA A23.1-04 standard specifies in article 4.2.3.5.2 (section "other reactions) that " the presence of sulfides, such as pyrite, pyrrhotite, and marcasite, in the aggregate that may oxidize and hydrate with volume increase, or the release of sulphate that produces sulphate attack on the cement paste, or both. "
- The CSA A23.1-04 standard (or other Canadian and/or Quebec standard) does not specify any maximum for sulfides that should be acceptable in a concrete aggregate.
- Problems relating to concrete sulphatation caused by the presence of iron sulfides are marginal and rare in Quebec and the rare cases that have been identified involved slightly argillaceous and calcareous aggregates that contained framboidal sulfides.

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PETROGRAPHIC EXAMINATION
ASTM C295 – ASTM C856

Client	Carrière B & B	File no	602071-0045
	St-Boniface (Québec)	Sample no	013
Project	Testing on materials	Client Ref.	N/D
		Date	December 12, 2005

2.0 RÉSULTATS (suite)

- The iron sulfides identified in the case of the Carrière B & B aggregates are rather massive and the low percentage of absorption of these aggregates minimizes the oxidation potential and subsequent sulphatation.
- Therefore, based on the results obtained, we are of the opinion that the risk of sulphatation of concrete, with a normal proportioning and having normal porosities and using these aggregates is low to nonexistent and should not represent a limitation to the use of these aggregates.

The percentage of iron sulfides can vary in this type of aggregate and a periodical control should be made to validate the percentage of sulfides contained.

Notes:

The methodologies and analysis techniques used are those recommended by the ASTM C295 norm. Considering the present scientific knowledge, they represent, in our opinion, an adequate global evaluation method for concrete aggregates.

- *Accordingly, the conclusions are a professional opinion that takes into account the results obtained with the methodology and techniques used and the experience acquired through case history.*
- *The results and conclusions found in this report apply to the sample analysed and not on a global evaluation of the quarry.*
- *There are presently no Canadian or Quebec norms regarding the presence of an acceptable percentage of iron sulfides in concrete aggregates. The vast majority of concrete aggregate used in the province of Quebec contains pyrite, at variable concentration.*

Testing done by: Terratech

Approved by:

Alain Blanchette, géol., M.Sc.A.
Project Manager
Materials Engineering

IQ510 147-REV 00(02-07)

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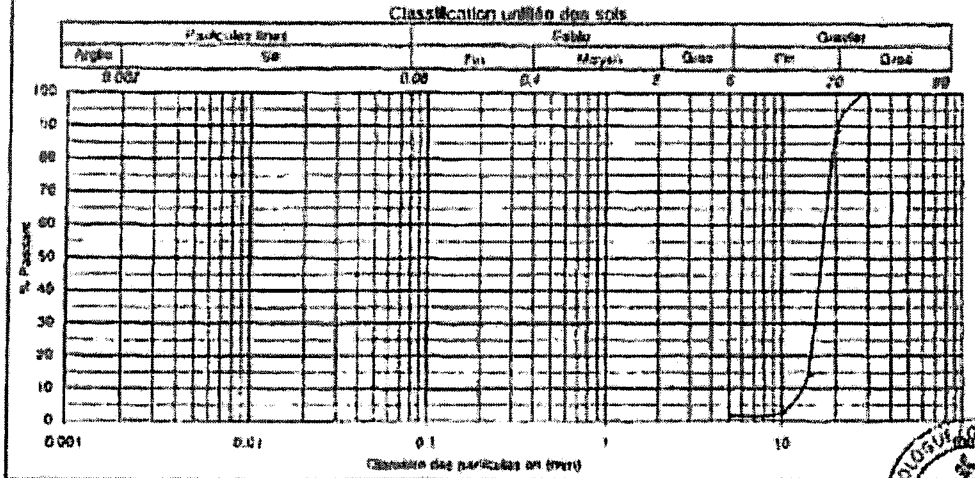
Essais sur sols, granulats et autres matériaux

Client :	Carrière B&B	Matériau :	P.C. 5-14, 10-20 et 14-20 mm (combiné)
:		Provenance :	Carrière B&B
Projet :	Carrière St-Boniface	:	St-Boniface, Québec
:		Utilisation :	Béton de ciment
No dossier:	602071-0045	Prélevé le :	Reçu le: 2005/08/17
Échantillon No :	013	Échantillonné par: Client	Réf.Client:

Analyse granulométrique (LC 21-040)			Autres essais		Mesuré	Exigé
Tamis mm	Tamisat (% Passant)		Examen pétrographique	ASTM C 295	(1)	
	Mesuré	Exigences	Analyse chimique			
112			- Équivalent pyrite (%)	NQ 2560-500	2.20	
80						
56						
40						
28	100					
20	89					
14	14					
10	3					
5	2					
2.500						
1.250						
0.630						
0.315						
0.160						
0.080						

Essai Proctor modifié (NQ 2501-255)		
Méthode	Masse volumique sèche maximale	Teneur en eau optimale

Classification unifiée des sols


Particules fines
Argile
Silt
Sable
Fin
Moyen
Gros
Gravier
Fin
Gros
0.002
0.08
0.4
2
5
20
80
100
90
80
70
60
50
40
30
20
10
0
% Passant
0.001
0.01
0.1
1
10
Diamètre des particules en (mm)

Remarques:

(1) Voir rapport ci-joint

Essais réalisés par: R.M.
Date: 2005/09/13

Vérifié par: G. Lamarche, technicien senior
Chef de laboratoire

Approuvé par: A. Blanchette géol. M.Sc.A.
Chargé de projet

GÉOLOGUE GEOLOGIST A. BLANCHETTE QUÉBEC

Essais-011-REV 0 (05-08) ws

October 31, 2006

Mr. Richard Beauchesne
Carrière B et B
8000, boul. Jean XXIII
Trois-Rivières, Québec
G9A 5C9

SUBJECT: Petrographic Examination according to ASTM C295
- Crushed stone 14-20 mm and 5-14 mm
  Carrière B et B
  St-Boniface, Québec

Our reference: 604523-0010, labo no 002

Sir,

We are pleased to submit to you the test results on the sample mentioned above.

The detailed results are found attached.

We hope this report is to your entire satisfaction and we encourage you to contact the undersigned should you require any further information.

Best regards,

TERRATECH,
A division of SNC-Lavalin Environnement Inc.

Alain Blanchette, geologist, M.A.Sc.
Project Manager
Materials Engineering

AB/nb

Enclosure Technical report

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Certifié ISO 9001

PETROGRAPHIC EXAMINATION

ASTM C295 – ASTM C856

Client	Carrière B & B	File no	604523-0010
		Sample no	002
Project	Testing on materials	Client Ref.	N/A
		Date	August 25, 2006

1.0 GENERAL INFORMATION

Type of samples	Crushed stone 14-20 mm and 5-14 mm
Instruments used	Polarizing optical microscope and thin section
Other information	N/A

2.0 RESULTS

1.0 GENERAL

We are in the presence of a crushed stone sample taken from Carrière B & B, located in St-Boniface, Quebec. The stones are of a 14-20 mm and 5-14 mm calibre.

A petrographic number (NQ 2560-900) was first conducted to determine, in megascopy, the types of facies and evaluate their mechanical properties. Afterwards, representative samples were mounted on thin section to determine more precisely the mineralogy in microscopy.

2.0 MEGASCOPIC DESCRIPTION

The sample is composed of a crushed stone of a 14-20 mm and 5-14 mm calibre.

The aggregates are of a dark to medium grey colour with a cubic to flat and elongated form. They are gabbroic in nature, with a holocristallin structure of phaneritic type.

82% of the sample is composed of a medium-grained anorthositic gabbro and 10% of the sample is composed of a fine-grained anorthositic gabbro. A slight surface alteration is visible on 8% of the sample.

We noted the presence of about 4 to 5% of iron sulfides (essentially pyrrhotite and pyrite) on the entire sample.

A petrographic number was conducted and the value obtained is 120. This result indicates that the mechanical properties of this stone are very good.

IO516-147-REV 01(06-06)

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CONFIDENTIAL LAF0000023052

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PETROGRAPHIC EXAMINATION
ASTM C295 – ASTM C856

Client	: Carrière B & B	File no	: 604523-0010
		Sample no	: 002
Project	: Testing on materials	Client Ref.	: N/A
	:	Date	: August 25, 2006

2.0 RESULTS (continued)

3.0 MICROSCOPIC DESCRIPTION

Representative samples were selected for a microscopic examination. The aggregates are all of a anorthositic gabbro composition. The stone presents a homogeneous and massive structure.
The sodium-calcium feldspars dominate the mineralogy (55%) followed by the pyroxene (30%). Afterwards, we note the amphiboles (hornblende at 4%), the biotite (4%), quartz (2%) and garnet (2%). The sodium-calcium feldspars present simple or complex twins. The crystals are rather hypidiomorphics and more or less equivalent. The pyroxenes (mostly orthopyroxenes) occasionally contain small sodium-calcium feldspar inclusions or pyroxenes. The crystals are hypidiomorphic and more or less equigranular. The biotite occasionally wraps the pyroxenes in a thin and discontinuous fringe. The quartz presents a low undulatory extinction. The opaque minerals, mostly iron sulfides, are present up to 5%. The chemical analysis conducted on a composite sample indicated a pyrite equivalent percentage of 4.5%. At the sample scale, the sulfides appear rather disseminated in their ensemble.

4.0 CONCLUSION

The petrographic number (NQ 2560-900) and the petrographic examination (ASTM C295) indicate that that sample analysed is of an anorthositic gabbro composition. The physical and mechanical properties appear very good, as demonstrated by the petrographic number and, in our opinion, meet the requirements for being used as concrete aggregate. The iron sulfides content was evaluated, through a chemical analysis, at 4.5%. There is presently no standard or specification in regards to the percentage of iron sulfides that a concrete aggregate can present. However, the measured percentage of iron sulfides can limit the use of the aggregate and we are of the opinion that it should not be used in the case of architectural concrete or in the case of exposed concrete aggregate.

Notes:

- *The methodology and analysis used are those recommended by the ASTM C295. Considering the present scientific knowledge, they represent, in our opinion, an adequate global evaluation method for concrete aggregates.*
- *Accordingly, the conclusions are a professional opinion that takes into account the results obtained with the methodology and techniques used and the experience acquired through case history.*
- *The results and conclusions found in this report apply to the sample analysed and are not representative of a global evaluation of the quarry.*

Testing done by: Daniela Munteanu, geol., intern

Approved by: ______________________
Alain Blanchette, geologist, M.Sc.A.
Project Manager
Materials Engineering

IG610-147-REV.01(05-06)

/725.2005 08:36 8193773718 BETON LAURENTIDE #7933 P.003 /006

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Essais sur sols, granulats et autres matériaux

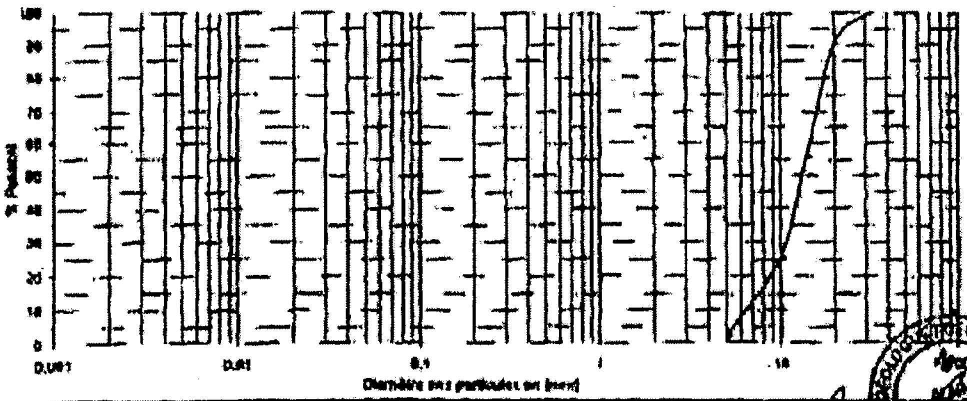
Client :	Carrière B & B	Matériau :	p.c. 14-20 mm et 5-14 mm		
:		Provenance :	Carrière B & B		
Projet :	Essais sur matériaux	:	St-Boniface, Québec		
:		Utilisation :	Remblai sous dalle		
No dossier:	604523-0010	Prélevé le :	2006/07/30	Reçu le:	2006/07/31
Échantillon No :	002	Échantillonné par:	le client	Ref Client:	

Analyse granulométrique (LC 21-040)		
Tamis mm	Tamisat (% Passant) Mesuré	Exigences
112		
80		
56		
40		
31.5	100	
20	91	
14	56	
10	28	
5	2	
2.50		
1.25		
0.63		
0.32		
0.16		
0.08		

Autres essais		Mesuré	Exigé
Nombre Pétrographique	NQ 2560-900	120	
Examen Pétrographique (1)	ASTM C 295	-	

Essai Proctor modifié (NQ 2501-255)		
Méthode	Masse volumique sèche maximale	Teneur en eau optimale

Classification unifiée des sols


Particules fines
Argile
Silt
Sable
Fin
Moyen
Gros
Gravier
Fin
Gros
100
90
80
70
60
50
40
30
20
10
0
% Passant
0,001
0,01
0,1
1
10
Diamètre des particules en (mm)

Remarques: (1) Voir rapport ci-joint

Essais réalisé par: [illegible]
Date: 2006/08/07

Vérifié par: G. Lafontaine, tech. sr
Chef de laboratoire

Approuvé par: A. [illegible], M.Sc.A.
Chargé de projet

[illegible]

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Télécopieur : [illegible]

ISO 9001

NOMBRE PÉTROGRAPHIQUE NQ 2560-900

Client : Carrière B & B	Date : Le 25 août 2008
	Dossier : 604823-0010
Projet : Essais sur matériaux	Labo n° : 002
	Réf. client : N/D

Échantillon	: p.c. 14-20 mm et 5-14 mm
Source	: Carrière B & B, St-Boniface (Québec)
Prélevé par	: Client — le : 30 juillet 2008
Localisation	: —

Masses utilisées

Passant	20	mm	Retenue	14	mm	Masse	506	g
Passant	14	mm	Retenue	10	mm	Masse	256	g
Passant		mm	Retenue		mm	Masse		g
Passant		mm	Retenue		mm	Masse		g

Tableau synoptique

Faciès pétrographiques	Facteur	retenu 14 mm	N.P.	retenu 10 mm	N.P.	retenu mm	N.P.	retenu mm	N.P.
Roche ignée de type gabbroïque à grains fins	1.0	12	12.0	8	8.0				
Roche ignée de type gabbroïque à grains moyens	1.2	81	97.2	82	98.4				
Roche ignée de type gabbroïque légèrement altérée en surface	1.5	7	10.5	10	15.0				
Nombres pétrographiques par fraction			118.7		121.4				

Nombre pétrographique : 120

REMARQUES

Des sulfures de fer sont visibles sur l'ensemble de l'échantillon (4%)

NOTES

Le nombre pétrographique réalisé selon la norme NQ 2560-900 représente une évaluation [illegible] propriétés physiques et mécaniques des matériaux analysés. L'identification des faciès pétrographiques présents est réalisée [illegible] et ne constitue pas une reconnaissance [illegible] de l'ensemble des minéraux présents. L'examen pétrographique [illegible] la norme ASTM C 295 prévoit des moyens d'analyse plus approfondies en microscopie, en sus, afin de déterminer [illegible] des matériaux.

Danièle [illegible], géol. stag.
Réalisé par

Vérifié par : Alain Blanchette géol. M.Sc.A.

Feuille 1 de 1

[illegible]

BETON LAURENTIDE

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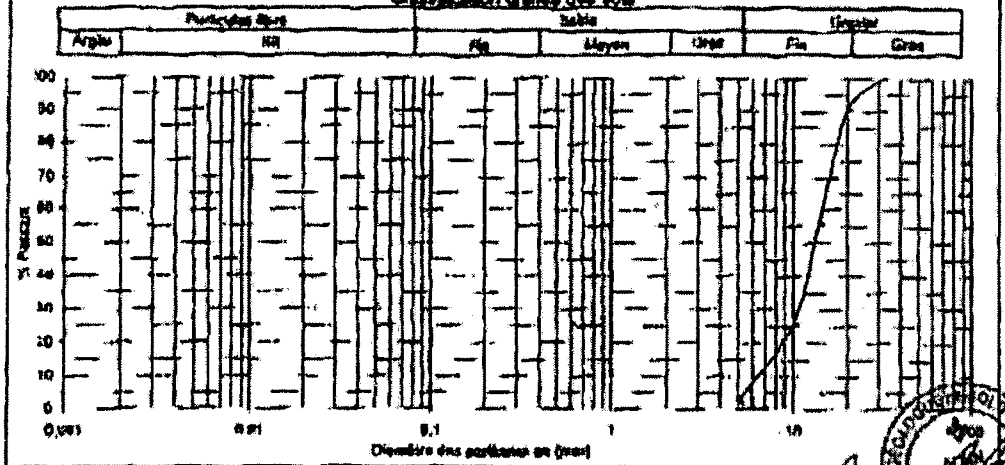
Essais sur sols, granulats et autres matériaux

Client :	Carrière B & B	Matériau :	p.c. 14-20 mm et 5-14 mm		
		Provenance :	Carrière B & B		
Projet :	Essais sur matériaux		St-Boniface, Québec		
		Utilisation :	Remblai sous dalle		
No dossier :	604523-0010	Prélevé le :	2006/07/30	Reçu le :	2006/07/31
Échantillon No :	002	Échantillonné par :	le client	Ref Client:	

Analyse granulométrique (LC 21-040)			Autres essais		Mesuré	Exigé
Tamis mm	Tamisat (% Passant)					
	Mesuré	Exigences				
112			Nombre Pétrographique	NQ 2560-900	120	
80			Examen Pétrographique (1)	ASTM C 295	-	
56						
40						
31.5	100					
20	81					
14	58					
10	28					
5	2					
2.50						
1.25						
0.63						
0.32						
0.16						
0.08						

Essai Proctor modifié (NQ 2501-255)		
Méthode	Masse volumique sèche maximale	Teneur en eau optimale

Classification unifiée des sols


Particules fines
Argile
Silt
Sable
Fin
Moyen
Gros
Gravier
Fin
Gros
% Passant
100
90
80
70
60
50
40
30
20
10
0
0,001
0,01
0,1
1
10
Diamètre des particules en (mm)

Remarques: (1) Voir rapport ci-joint

Essais réalisés par: I.L.L.
Date: 2006-08-07

Vérifié par: G. Laliberté, tech. sr
Chef de laboratoire

Approuvé par: A. [illegible], ing., M.Sc.A.
Chargé de projet

ORDRE DES GÉOLOGUES DU QUÉBEC

CD-10-01 (REV.01/05/04)